2

DOT/FAA/AM-92/3

Office of Aviation Medicine
Washington, D.C. 20591

Human Factors Evaluation of the Work Environment of Operators Engaged in the Inspection and Repair of Aging Aircraft

Richard I. Thackray

Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, OK 73125

January 1992

Final Report

This document is available through the National Technical Information Service, Springfield, Virginia 22161

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-92/3		
4. Title and Subtitle: Human Factors Evaluation of the Work Environment of Operators Engaged in the Inspection and Repair of Aging Aircraft		5. Report Date: January 1992
		6. Performing Organization Code
7. Author(s): Richard I. Thackray, Ph.D.		8. Performing Organization Report No.
9. Performing Organization Name and Address: FAA Civil Aeromedical Institute, P.O. Box 25082, Oklahoma City, OK 73125		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address: Office of Aviation Medicine, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591		13. Type of Report and Period Covered
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Site evaluations of air carriers and repair stations conducting inspections and heavy maintenance on PART 121 aging aircraft were conducted during 1989-90 under the FAA's Office of Flight Standards Aging Fleet Evaluation Program. This report presents the findings of the human factors portion of this program in which aspects of the work environment of selected operators were evaluated with respect to illumination levels, noise, temperature/ventilation, work support equipment/workspace adequacy, occupational safety, and extent of worker overtime. Data are reported for 19 site evaluations. While 89 percent of the operators were given global ratings of acceptable or better in the area of human factors, the deficiencies noted were quite consistent across carriers and repair stations. Illumination levels, in particular, were found to be considerably below levels recommended by the Illuminating Engineering Society. There were also deficiencies in work support equipment and in compliance with the operator's stated safety program. Recommendations are given for improvements in each of these areas.

17. Key Words		18. Distribution Statement
Aging	Inspection	Document is available to the public through the National Technical Information Service, Springfield Virginia 22161
Aircraft	Maintenance	
Aviation	Safety	
Environment	Workplace	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	16	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

HUMAN FACTORS EVALUATION OF THE WORK ENVIORNMENT OF OPERATORS ENGAGED IN THE INSPECTION AND REPAIR OF AGING AIRCRAFT

INTRODUCTION

On April 28th, 1988, a 19 year old Aloha Airlines Boeing 737 flying from Hilo to Honolulu experienced an explosive decompression and structural failure at 24,000 feet. Approximately 18 feet of the cabin skin and structure aft of the cabin entrance door and above the passenger floorline separated from the airplane during flight. Of the 89 passengers and 6 crewmembers on board, one flight attendant was swept overboard, with 7 passengers and 1 flight attendant receiving serious injuries. The flight crew performed an emergency descent and landing at Kahului Airport on the Island of Maui (5).

The striking photographs of Aloha passengers strapped to their seats in the topless aircraft galvanized the aviation community into almost immediate action, with maintenance procedures suddenly subjected to intense scrutiny by the Federal Aviation Administration (FAA), airlines, manufacturers, the research community, and Congress (1). It soon became apparent, from the National Transportation Safety Board (NTSB) public hearings and other sources, that the structural damage that occurred to the Aloha 737 was at least partially the result of failures on the part of Aloha inspectors to detect the faults, cracks, and corrosion that contributed to this incident. Many programs and task groups were spawned from this initial focus on the human element in maintenance and inspection of older aircraft. Most, however, are not of direct relevance to the present report and have been documented elsewhere (1). The program under which the data presented here were gathered was the FAA's Office of Flight Standards Aging Fleet Evaluation Program. For background purposes, essential aspects of this program will be briefly reviewed.

The basic objectives of the aging fleet evaluation program, as given in a recent FAA technical report (2), were as follows:

(a) Assess the current condition of transport category aircraft most commonly used in US air carrier operations.

(b) Evaluate air carrier maintenance programs in areas relating to aging aircraft, particularly structural inspections and corrosion control, non-destructive testing, major repairs, and human factors, and assess the ability of these programs to ensure the continued airworthiness of aging aircraft.

(c) Provide airworthiness inspectors information and guidance that is applicable to current operations of the aging fleet.

Boeing (707, 727, 737, and 747) aircraft and McDonnell-Douglas (DC-8, DC-9, and DC-10) aircraft were the types selected for the evaluations. On-site evaluations were scheduled to coincide with older aircraft (generally 13 to 24 years old and selected from one of the above types) that were undergoing a D-check or similar type of heavy maintenance operation. Each evaluation was conducted over a period of approximately 9 days by a team of 6-8 experienced FAA inspectors and managers, 1-2 engineers, and a human factors specialist. Evaluation checklists were used to ensure a high level of consistency and to help consolidate and analyze the results. The evaluations were conducted between March 1989 and August 1990. It was determined that 23 aircraft would provide an adequate sample and could be reviewed within the desired time frame.

The human factors aspects of the aging fleet evaluation were coordinated through the FAA's Office of Aviation Medicine under Dr. William T. Shepherd. Shortly after the program site evaluations actually began, implementation of the human factors portion of this program was transferred to the FAA's Civil Aeromedical Institute and placed under the direction of the author.

METHOD

As indicated earlier, each specialist on an evaluation team was provided a checklist. Determination of what to include in a human factors checklist of maintenance worksites was not an easy task. Obviously, there are many human factors issues relevant to maintenance/inspection performance that might have been assessed during these site evaluations. Relevant human factors variables might include such things as the adequacy of the tools (including work support equipment) being employed, the levels and adequacy of on-site training, what job aids, if any, were being used, what evidence was there of excess stress and/or fatigue among workers, what safety hazards existed that might impair performance, what were the lighting and noise levels, etc.

Because of time constraints (the human factors evaluation typically was completed within two working days), it was decided to confine the evaluation to those aspects of the work environment that could be reasonably and reliably assessed within that time frame and that also were of greatest interest to managers of the aging fleet program. The human factors areas chosen for assessment in the checklist included lighting, noise, temperature/ventilation, work support equipment, occupational safety, and worker overtime/fatigue.

As indicated earlier, the human factors portion of a site visit was generally completed within two days. The first day was spent in taking light and sound level measurements and in checking items on the list pertaining to work space and work stands, temperature and ventilation, and safety considerations. These data were gathered during both day and night shifts. In addition, interviews were scheduled with various supervisors and managers to obtain information for those items which could not be obtained through direct observation. Informal talks were also held with mechanics and inspectors to supplement and/or corroborate various checklist items. The second day was generally spent completing checklist items and in writing a summary report of the findings along with recommendations. The report and recommendations were reviewed with the team leader who incorporated the findings and recommendations in his out-briefing with the operator. In order to assure operators that these evaluations were not some form of FAA inspection, Flight Standards required that none of the checklists contain information that could identify the operator. Consequently, no mention of particular carriers or repair stations will be made in this report.

The checklist used in the evaluations is given in Appendix A. As noted earlier, it contained items relating to lighting, noise, temperature/ventilation, workspace/worksupport considerations, occupational safety, and worker overtime. In addition, there were a number of miscellaneous items relating to such things as whether or not the operator employed anyone with a background in human factors/ergonomics/industrial psychology, whether the operator had any awards, incentives, or special recognition programs, and several items dealing with how much time was spent in conducting the human factors evaluation and which shifts were evaluated. Finally, there was a simple scale designed to give a global human factors rating of the operator.

RESULTS AND DISCUSSION

Although site evaluations began in March of 1989, the human factors checklist was in the development phase during the first three evaluations and was not actually utilized until the fourth evaluation. Consequently, the data reported here were derived from 19 of the 23 total aging fleet site evaluations.

Summary data for each of the items are shown in Appendix A. Unless otherwise stated, the data referred to throughout the remainder of this report are taken from those shown in this Appendix. It may be noted that some of the items contain data based on less than 19 observations. There are several reasons for this: It was not always possible to obtain the required information either because, as was the case in a few of the evaluations, a human factors specialist was not available to participate in the site visit, or the needed information was simply not available. A good example of the latter is item 1.e.1) "Is the lighting used for difficult visual inspections adequate?" In order to answer this question, the site evaluation had to coincide with a time in which visual inspections were being made. That was not the case in about half of the evaluations.

Illumination

1. Hanger (overhead) lighting: Typically, lighting was supplied by mercury vapor, metal halide, or high-pressure sodium lights. These differ in their color rendition, with some better in this respect than others. However, for most aircraft repair/inspection procedures, color rendering properties of the light source are probably not too important. Illumination supplied by overhead lights within hanger areas was generally found to approach recommended levels for most types of repair work performed on upper and lateral surfaces of the aircraft. Measured levels averaged 64.3 foot candles (fc) during the day and 48.9 fc at night. (Illumination measurements were expressed in foot candles rather than lux, the SI measure, because foot candles were more readily understood by team members and, it was easier to convey the meaning of low light levels to operators during out-briefings when levels were expressed in foot candles.) These average levels do not quite reach the 75 fc level recommended by the Illuminating Engineering Society for virtually all aircraft repair tasks (3), but, as will be seen shortly, they were considerably closer to this recommended level than illumination measured in other aircraft repair areas.

2. Lighting below wings, fuselage, and within cargo areas: Because these areas are partially shielded from light supplied by overhead fixtures, supplemental light sources were often employed. The most frequently used types of supplemental lights were quartz halogen stand lights, dual 40W florescent fixtures, and flashlights. While all of these lights are capable of providing sufficient light for most repair and inspection tasks, the typical observation was that they were often placed too far from the work being performed and, almost without exception, there were too few lights being used. The result was that lighting varied widely from one work location to another. Levels averaged 24.5 fc during the day and 12.2 fc during the night, with readings as low as 2 to 4 fc not uncommon.

These latter levels are extremely low for performing almost any type of aircraft repair task.

3. Lighting levels within fuselage areas: The most common forms of supplemental lighting used within cabin/cargo areas were single, dual, or four-sided 40W florescent fixtures. By themselves, the lights were generally capable of producing adequate light for work being performed. However, as already noted, and almost without exception, too few lights were employed, and they were often located too far from actual work areas. Consequently, levels were typically as low as those obtained beneath the aircraft. Levels averaged 20.3 fc during the day and 15 fc at night.

4. Lighting for visual inspection: Inspectors generally used standard 2 D-cell flashlights. For visual inspection of small areas, this type of lighting is entirely adequate. Assuming batteries are in good condition, light from such flashlights (ranging from 100 to 500 fc) is completely adequate for visual inspection. Use of smaller, halogen "Maglites" appears to be increasing. The amount of illumination from such lights (approximately 60 to 180 fc at a distance of one foot from a 2 AA-cell Maglite) is less than that provided by D-cell flashlights, and the area illuminated is much smaller. While desirable because of their size, until further research is done, use of such lights for visual inspection is not recommended.

Noise

Average levels within hanger areas were measured and found to average 75 db(A) with little variation from site to site. This level is quite low and requires no ear protection. There were, however, intermittent periods when riveting and other pneumatic tools were being used that levels above 90 db(A) were recorded. Because these high noise level periods were generally infrequent and discontinuous, ear protection would only be required by workers using the tools and by those workers in immediately adjacent areas. It was observed that, while workers using impact tools typically wore ear plugs, workers in adjacent areas were often observed not to be wearing any form of ear protection. In addition, ear plugs were not always inserted properly. Without ear protection, continuous exposure to noise levels in excess of 85 db(A) over an 8-hour working day may cause permanent hearing loss, with exposure duration halved for every 3 db(A) above this level (4). Since pneumatic tools are quite capable of producing noise levels in excess of 110 db(A), exposure to noise at this level without ear protection should not exceed 12 minutes in an 8-hour day.

Temperature/Ventilation

Temperature of the work environment, humidity levels, and level of air movement for ventilation were satisfactory in virtually every evaluation. Most of the evaluations took place during times of the year or in geographic locations in which outside temperatures were quite reasonable. Consequently, primary ventilation was typically provided by normal air movement through open or partially open hanger doors supplemented by fans or blowers. Average temperature was 77.1 degrees F. Relative humidity was normally within an acceptable 10 to 60 percent range. No instances were noted of noxious/hazardous fumes at the work site.

Work Space/Work Stand Considerations:

In general, most hangers were of sufficient size to accommodate the entire aircraft, although there were two instances in which the empennage extended beyond the hanger area. While a few operators provided excellent fixed scaffolds and work platforms specifically configured to the fuselage and empennage areas of the aircraft being modified/repaired, most operators were somewhat deficient in this respect. It was more typical to find operators using a variety of fixed and moveable scaffolds and platforms, ladders, stools, and "cherry pickers." This does not necessarily imply that work cannot be satisfactorily accomplished with many of these types of work support stands. However, work stands and platforms not specifically configured to a particular aircraft may present some safety hazards and can result in increased fatigue if placement of the stands requires working in awkward positions. The use of "cherry pickers" in particular is not deemed a desirable practice. The inherent instability of such platforms may make it difficult to perform visual inspections and/or maintenance, especially maintenance in which torsional forces are required. This instability is also believed to be a source of distraction and concern to some workers which could contribute to inefficient performance.

Occupational Safety Considerations:

It was not the intent of the human factors team member to perform Occupational Safety and Health Administration (OSHA)-type work site evaluations or to act as OSHA representatives or inspectors. Nevertheless, safety considerations were included in the checklist because it was felt that an operator's general health and safety program not only reflected its attitudes towards the workforce, but a safety conscious organization has a positive effect on worker performance by encouraging the employee to recognize hazards, take precautions, and thus be minimally influenced by distractions caused by unsafe working conditions. With this in mind, most operators had adequate safety programs; some were exceptional, while a few could be considered only marginally adequate. Although exceptions were noted, and these will be discussed shortly, the data shown in Appendix A reveal that most operators provided workers with (a) ear, breathing, and eye protection; (b) adequate numbers of first aid kits and supplies to treat minor injuries; (c) training in the use of hazardous materials/chemicals; (d) adequate rest breaks and rest area/changing room facilities; and (e) safety lines and harnesses when working on the crown of the fuselage. Ninety-four percent of the operators had accessible Material Safety Data Sheets for hazardous materials, although only about 75% actually had an OSHA Written Hazard Communication Program.

The exceptions referred to above had to do mostly with implementation of safety programs. Frequent instances were noted in which there was inconsistent compliance with the operator's stated program. Thus, while many workers were observed to be using ear, eye, and breathing protection when required by the work being performed, others were not. As indicated in the previous section dealing with noise, this was particularly true in the case of ear protection; workers using impact tools generally wore protection, but adjacent workers would not be similarly protected. Other illustrations were foot protection and safety lines; an operator might state that use of safety lines was mandatory, or that employees were not allowed to wear canvas shoes. However, failure to comply with these stated requirements was fairly common.

Overtime, Shift Schedules and Fatigue

Ninety-five percent of the operators reported that some of their maintenance personnel were working in excess of assigned shift hours. When asked what percentage of their employees worked overtime, the average was 35%. This latter value, however, is somewhat misleading. Examination of the raw data revealed a bimodal distribution; fifty-eight percent of the operators stated that 10 or fewer percent of employees worked overtime, while 26% stated that all employees worked some overtime. Of greater importance was the finding that the average amount of overtime per week was stated to be 6.3 hours (SD=5.8). There was no visible evidence that overtime was resulting in apparent fatigue-related problems. This observation must be tempered, however, by the fact that observations of workers could only be made during the relatively short time periods encompassed by the site visits. Also, many operators stated that on occasion, when work demands required, workers might put in long periods (4 to 6 weeks) of considerable overtime, and it is during these periods that fatigue might be expected to manifest itself. It should be emphasized, though, that the extent of fatigue during such periods could not be determined from these brief site visits.

Shift preference was generally based on seniority, with the more senior workers typically choosing day and evening shifts. Only one of the operators indicated that any type of shift rotation was used; shifts 1 and 2 were rotated every 4 weeks, while the third (midnight) shift was permanently assigned.

Human Factors Staffing

Although 26% of the operators had some person who was designated as being in charge of "human factors", that person typically was the same person who had responsibility for the occupational safety program. While several of the operators had industrial hygienists with training in human factors, none had any individuals in management whose sole responsibility was human factors. Relatively few (24%) of the operators stated that they had ever utilized a human factors specialist to monitor or assess the work environment and, in talking with management, one got the impression that a human factors consultant, if employed, was generally a lighting consultant.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

As may be apparent from the previous sections of this report, the maintenance work environment of the various carriers and repair stations evaluated was remarkably consistent across operators, and as noted in item 11 of Appendix A, 17 or 89% of the operators were given global ratings of acceptable or better in the area of human factors. While this would appear to be an encouraging statistic, it should be interpreted to mean only that the work environment was judged to be at least minimally acceptable for accomplishing required tasks.

There were certain aspects of the work environment observed during the site evaluations in which deficiencies were commonly noted. These are given below along with summary observations and recommendations for improvement:

* **Workplace Illumination**

Observations: The single most common deficiency noted pertained to levels of work illumination. It was pointed out earlier that the Illuminating Engineering Society (IES), in their 1989 Lighting Application Volume, recommends a minimum level of 75 fc for virtually all aircraft repair tasks (3). These tasks include maintenance, modification and repairs to airframe structures, modifications or repairs to aircraft systems, and system restoration or new system component installation. For visual inspections, the IES recommends minimum levels of 50 fc for ordinary area inspection, 100 fc for difficult inspection, and 200 fc for highly difficult inspection. While light from a 2 D-cell flashlight provides a level of illumination that meets the IES requirements for difficult visual inspection tasks, it is apparent from the data given that most aircraft maintenance tasks were being performed under illumination levels that were considerably below the 75 fc recommended level.

Recommendations: In the absence of any other known guidelines for aircraft maintenance tasks, it is recommended that operators increase illumination levels for those repair tasks performed within and beneath aircraft to the 75 fc level recommended by the IES.

* **Work Support Equipment**

Observations: A second, and less consistent, observation pertained to the adequacy of work support platforms. A wide variety of moveable platforms, stands, scaffolds, and ladders were used to access work areas. While sometimes required by the work being performed, it was not unusual to see such support equipment used in an unsafe manner, or in ways that could contribute to worker fatigue.

Recommendations: It is a recommendation of this report that stable work platforms specifically configured to a given aircraft's fuselage and empennage be used more extensively to replace the variety of stands frequently employed. In particular, the extensive use of "cherry pickers" in place of stable work stands that was noted in some site visits is not considered good practice. It is recommended that use of this type of work platform be kept to an absolute minimum, with more stable platforms used in their place.

* **Compliance with Stated Safety Program**

Observations: A third general observation was the pattern of inconsistent worker compliance with requirements of the operator's stated safety program. In particular, there was inconsistent usage of ear, eye, and foot protection, and in employment of safety lines and harnesses when required by the work being performed.

Recommendations: It is recommended that carriers and repair stations review their safety programs to ensure that workers are provided with adequate training in the need for and benefits to be derived from safe work habits. In conjunction with this, there is also a need for management to more closely monitor the work site to ensure greater compliance with the stated safety program.

* **Human Factors Input**

Observations: As a final observation, it was noted that only about a fourth of the operators evaluated had any "human factors" person on their staff or had ever employed a human factors consultant to assess the work environment. While it is probably unrealistic to expect most operators to employ a full-time human factors specialist, it does not seem unrealistic to expect carriers and repair stations to utilize consultants on a periodic basis to provide a human factors assessment of the work environment.

Recommendations: To the extent that a carrier or repair station does not have a trained human factors specialist on its staff, it is recommended that a human factors consultant be employed on a periodic basis to provide a comprehensive assessment of the operator's total work environment.

REFERENCES

1. Aging Aircraft Issue Presents Major Challenge of Industry. Special Report: The World Fleet Grows Older. Aviation Week & and Space Technology, July 24, 1989.

2. Federal Aviation Administration. (1991) Aging Aircraft Evaluations of Large Transport Category Aircraft in Part 121 Operations. Final Report, January 1991.

3. Illuminating Engineering Society (IES) Lighting Handbook: Application Volume, 1987.

4. Jones, D. M. and D. E. Broadbent. (1987). Noise. In G. Salvandy (Ed.), Handbook of Human Factors. NY: Wiley.

5. National Transportation Safety Board (1989, June). Aloha Airlines, Flight 243, Boeing 737-200, N73711, near Maui, Hawaii, April 28, 1988. Washington: NTSB Report No. NTSB/AAR-89/03.

APPENDIX A

HUMAN FACTORS CHECKLIST (Including Summary Data from 19 Site Evaluations)

1. LIGHTING

a. What types of lighting are utilized? Incandescent 4 Florescent 12 Flood 5 Overhead 19 Mercury Vapor 6 Quartz Halogen 7 Metal Halide 3 Sodium 8 .

b. Are overhead lighting fixtures supplemented by flood lights at work stations?

Yes 14   No 5

1) Is overhead lighting adequate for general hanger illumination?

Yes 18   No 0   ((Approximately 20-50 foot candles (fc) recommended for general area illumination))

Average levels (in fc) if measured:

Day   Mn=64.3; SD=22.6; Range=34.5 to 100+

Night Mn=48.9; SD=25.5; Range=24.5 to 100

c. Are there adequate lighting fixtures to properly illuminate the work area?

Yes 10   No 8

d. Are supplemental lights being used under wings, inside the airplane, or in other areas shielded from overhead illumination?

Yes 18   No 1

Type: Mostly florescent, some use of quartz halogen stand lights and flashlights

Wattage: Typically, single or dual 40W florescent fixtures

1) Average levels (in fc) if measured (50-100 fc recommended)

(a) beneath the aircraft:

Day   Mn=24.5; SD=27.6; Range=2.5 to 100+

Night Mn=12.2; SD=18.9; Range=2.0 to 72

(b) inside the aircraft:

Day _Mn=20.3; SD=13.0; Range=< 1 to 42_

Night _Mn=15.0; SD=15.2; Range=< 1 to 47_

e. Is the lighting adequate and are the fixtures placed for best effectiveness, i.e., minimize glare?

Yes _8_ No _8_

1) Is the lighting used for difficult visual inspections adequate?

Yes _9_ No _1_ (100-500 fc recommended for difficult visual inspection)

2) What types of lights are used when visually inspecting for cracks, flaws, and defects?

Standard 2 D-cell flashlight _9_ Halogen flashlight _4_ Handheld high intensity "jet" lights _2_ Other types _Some use of AA-cell Maglites and hand-held florescent tubes_

2. NOISE LEVEL

a. Are riveting operators, as well as other employees exposed to high noise levels, provided with proper ear protection (plugs/muffs)?

Yes _18_ No _1_

b. Is average ambient noise level for workers not wearing ear protection at an acceptable level?

Yes _17_ No _1_ Average dB(A) level if measured _Mn=75; SD=4.3_

c. Are workers in or outside of the airplane, adjacent to the riveting operations wearing ear protection?

Yes _14_ No _5_

d. Were noise levels measured or noise exposures monitored before issuing ear plugs?

Yes _9_ No _8_

e. Have high noise areas been defined and posted with "Hearing Protection Required in this Area" signs?

Yes _1_ No _15_

f. Was any instruction provided in the use of and need for ear protection?

Yes _18_ No _1_

d. Is hearing checked on an annual basis and are hearing check results explained to employees?

Yes _10_ No _7_

3. TEMPERATURE/VENTILATION

a. Is the work place heated?

Yes_16_ No_3_

b. What is the average temperature (in degrees F) during working hours? ____Mn=77.1; SD=7.1; Range=65 to 89

1) Is average relative humidity less than 60% and greater than 10%?

Yes_11_ No_4_

c. How is ventilation accomplished?

Open Hanger Doors_20_

Central Exhaust System_5_

Roof Ventilators_1_

d. Are exhaust fans or blowers utilized?

Yes_16_ No_3_

e. Are the number of fans/blowers in the work area sufficient to provide good working conditions?

Yes_19_ No_0_

1) Is adequate exhaust ventilation provided in areas involving:

grinding/sawing	Yes_15_	No_0_	Not Applicable/determinable_4_
solvent use	Yes_15_	No_1_	Not Applicable/determinable_2_
welding	Yes_11_	No_0_	Not Applicable/determinable_7_
spray painting	Yes_10_	No_1_	Not Applicable/determinable_8_
sand blasting	Yes_11_	No_0_	Not Applicable/determinable_7_

f. Are there any type of noxious/hazardous fumes present at the work site?

Yes_0_ No_17_

4. WORK SPACE DESIGN/LAYOUT

a. Is there sufficient room for workmen to accomplish task? (Take aircraft size into consideration).

Yes_19_ No_0_

b. Is the facility large enough to house aircraft?

Yes_17_ No_2_

c. Are there adequate numbers and types of work platforms, stands, and other support equipment to enable optimal access to work being performed?

Yes 18 No 1

d. What types of platforms are used?

Fixed 14 Moveable 18 Scaffold 17 Other Five operators used "cherry pickers" extensively

5. GENERAL SAFETY CONSIDERATIONS

a. Are workers provided with sufficient number and type of protection for

eyes?	Yes 18	No 1
breathing?	Yes 18	No 1
ears?	Yes 18	No 1
hands/feet?	Yes 17	No 2

b. Are workers provided with rest breaks?

Yes 19 No 0

1) If "yes", how often and how long are the breaks?

All indicated two work breaks during a shift in addition to a meal break. Thirty-eight percent of the operators stated that work breaks were 10 minutes in length, 50 percent indicated breaks were 15 minutes long, and 11 percent indicated breaks were 20 minutes in length.

c. Is there a separate rest area free from noise?

Yes 19 No 0

d. Is there a First Aid facility?

Yes 15 No 4

e. Are there sufficient First Aid kits to treat minor injuries?

Yes 18 No 1

f. Is there a changing room or wash room?

Yes 19 No 0

g. Is there adequate disposal of hazardous materials? (i.e., cleaning solvents, paint strippers).

Yes 19 No 0

h. Are safety lines or appropriate devices utilized?

Yes_16_ No_3_

i. Does the airline or repair station have a Written Hazard Communications Program ?

Yes_13_ No_4_

j. Are Material Safety Data Sheets (as required by OSHA) accessible at work stations where hazardous chemicals are employed?

Yes_17_ No_1_

k. Has training been provided in the use of hazardous materials/chemicals?

Yes_14_ No_3_

l. Are product and chemical containers labeled to adequately warn workers (in language understandable to employee) of toxic, flammable, corrosive, or special hazards?

Yes_14_ No_2_

m. Are respirators provided when required by work performed?

Yes_16_ No_1_

n. Are respirators fit tested at least annually and checked for functioning?

Yes_12_ No_6_

o. Are workers provided with eye protection when required by the work performed?

Yes_17_ No_2_

p. Is adequate protection provided for hands/feet when required?

Yes_9_ No_7_

q. Are records maintained (as required by OSHA) of accidents and illnesses?

Yes_18_ No_0_

r. Are maintenance personnel working in excess of the assigned shift hours?

Yes_18_ No_1_

If "yes", on the average what percentage of the maintenance personnel work in excess of the assigned shift hours?
_35_%

If "yes", on the average how many extra hours do the maintenance personnel work in excess of the assigned shift hours? 6.3 hours

1) Are shifts

permanently assigned 13

rotated 1

2) If rotated, what type of shift rotation schedule is used?

One operator rotated 1st and 2nd shifts, 3rd shift permanent

7. a. Is there a human factors or ergonomics staff person assigned to the organization?

Yes 5 No 14

b. Has a human factors consultant been utilized to monitor or assess the workplace environment?

Yes 4 No 13

8. Does the operator have awards, incentives, or special recognition programs for employees?

Yes 12 No 6

9. How many manhours were used for the actual Human Factors evaluation?

Number of manhours___________

10. Which shifts were evaluated by the FAA team?

Shift 1___ Shift 2____ Shift 3____

11. An appropriate scoring should be circled for the Human Factors program using (1) to indicate poor, (3) to indicate acceptable, and (5) to indicate excellent; note that the scoring is a judgement of the effectiveness of that operator's program, not a rating of the carrier with respect to another carrier.

Scale Value	No. in Category
1	1
2	1
3	10
4	5
5	2

12. This section requires a description (word picture) of your total evaluation. Include positive/negatives of the operator's human factors program. Any comments should be able to be substantiated by reference to the observations and/or recommendations above.

*U.S.GPO:1992-661-063/40026